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BRUCE NGS "B" UNIT 8 IN-SERVICE INSPECTION OF CONCRETE CONTAINMENT BOUNDARY

Report No. 90-230-K

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ABSTRACT

An inspection of the concrete containment boundary of the Bruce NGS "B" Unit 8 reactor building was carried out in June 1990. The concrete appeared in good condition, with the exception of a few hairline cracks and two spalled areas.

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BRUCE NGS "B" UNIT 8
IN-SERVICE INSPECTION OF
CONCRETE CONTAINMENT BOUNDARY

1.0 INTRODUCTION

An inspection of the accessible exterior concrete containment boundary of the Bruce NGS "B" Unit 8 reactor building and associated portion of the fuelling machine duct was carried out from June 18 to 21, 1990. The inspection, which followed the work plan prepared by the Central Production Services Department, consisted of visual observation and nondestructive testing. This report summarizes the results of the inspection.

2.0 INSPECTION RESULTS

The visual observations are summarized in Tables 1, 3 and 4. The nondestructive test results are given in Table 2. The locations inspected are listed below:

(a) Accessible areas on the exterior of the reactor building (Tables 1 and 2, Figures 1 to 6).

(b) High stress areas on the exterior of the reactor building (Tables 1 to 3, Figures 7 to 10).

(c) Accessible areas of the breakout panel (Table 1, Figure 11).

(d) Concrete around randomly selected embedded parts - EP - (Table 1).

(e) Concrete in the rooms located in the reactor building basement (Table 1).

(f) Concrete around Air Locks 2 and 5 (Table 1).

(g) Concrete around the post-tensioning anchorage system of the main girders (Tables 1, 2 and 4, Figures 12 to 15)

(h) Concrete around the embedded parts for the preheater containment enclosure anchorage (Table 1, Figures 16 to 21).

(i) Concrete around the primary heat transport pump supports (Table 1).

(j) Concrete around the steam generator supports (Table 1).

(k) Accessible areas of the fuelling machine duct wall in the vicinity of Unit 8 (Table 1, Figures 22 and 23).

3.0 DISCUSSION

Most of the cracks present in the perimeter walls of the reactor building and in the main girders were less than 0.15 mm wide and covered with paint. Numerous cracks were observed in the north wall of the reactor building. In general, the cracks were randomly orientated, except in the girders where cracks propagated from the anchorage zones. In a few of the high stress areas at Elevation 663', horizontal cracks up to 0.50 mm wide were present. The nondestructive test results indicated that the concrete in the perimeter walls and girders was in generally good condition. Selected cracks evaluated nondestructively were estimated to extend a maximum of 220 mm into the concrete.

Hairline cracks were present in the concrete around the preheater containment enclosure anchorages. An area of spalled concrete was present on the south wall of the east boiler room. Adjacent to the preheater enclosure, the concrete had previously been repaired near the spall.

Cracks, generally less than 0.15 mm wide, were observed in the wall of the fuelling machine duct. A small area of spalled concrete exhibiting efflorescence was observed along one of the vertical construction joints in the wall. The nondestructive test results indicated that the concrete was of good quality. Selected cracks were estimated to penetrate a maximum of 235 mm into the wall.

4.0 CONCLUSIONS

The concrete appeared in good condition, with the exception of a few hairline cracks and two spalled areas. The presence of such cracks is expected and normal in concrete. The structural significance of the spalled concrete in the south wall of the east boiler room and the area of spalled concrete exhibiting efflorescence on a vertical construction joint in the fuelling machine duct wall should be evaluated.

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EJM:mao

Table 1

Bruce NGS "B" Unit 8
In-Service Inspection of Concrete Containment Boundary

Inspection Location		Observations
(a)	Accessible areas on the exterior of the reactor building	- the location of cracks noted on the exterior of the reactor building are shown in Figures 1 to 4 - in general, only hairline cracks (widths <0.15 mm) were noted and many of these had been covered with paint - the north perimeter wall to the east and west of the breakout panel contained numerous random hairline cracks (Figures 5 and 6)
(b)	High stress areas on the exterior of the reactor building	- the observations made of the high stress areas are summarized in Table 3 and Figures 7 to 10
(c)	Accessible areas of the breakout panel	- the location of cracks observed in the breakout panel are shown in Figure 11 - the cracks generally extended from the embedded parts and were less than 0.15 mm wide, with a few exceptions where the cracks were up to 0.25 mm wide.
(d)	Concrete around randomly selected embedded parts	- a few minor hairline cracks were present in the concrete around the embedded parts inspected in the perimeter of the reactor building
(e)	Concrete in the rooms located in the reactor building basement	- the wall of the fuelling machine duct was visually inspected from the moderator heat exchanger rooms - the wall was covered with paint and a black flexible coating that made inspecting the concrete difficult - no significant cracks or defects were noted in this wall
(f)	Concrete around Air Locks 2 and 5	- no cracks or defects were noted in the concrete around the two air locks inspected
(g)	Concrete around the post-tensioning anchorage system of the main girders	- the locations of cracks present in the vicinity of the post-tensioning anchorages are summarized in Table 4 and Figures 12 to 15 - at the ends of the girders, the cracks were randomly orientated - at the anchorage zones cracks extended from the anchors - along the length of the girders, vertical cracks were noted

Table 1 (cont'd)

Bruce NGS "B" Unit 8
In-Service Inspection of Concrete Containment Boundary

Inspection Locations		Observations
(h)	Concrete around the embedded parts for the preheater containment enclosure anchorages	- the locations of cracks are shown in Figures 16 to 21 - only minor cracks (width < 0.15 mm) were observed in the concrete - on the south wall of the boiler room adjacent to the southeast preheater, an area of spalled concrete was identified
(i)	Concrete around the primary heat transport pump supports	- the floor was dirty which made viewing the cracks and estimating their widths difficult - random cracking (width < 0.15 mm) was observed in the floor
(j)	Concrete around the steam generator supports	- the concrete in this area was not inspected
(k)	Accessible concrete on the exterior of the fuelling machine duct walls in the vicinity of Unit 8	- vertical and horizontal cracks (width < 0.15 mm) were present in the concrete (Figure 22) - at one location between Col Lines 8P and 8O, at a vertical construction joint, a small area of spalled concrete with efflorescence was observed (Figure 23)

Table 2

Bruce NGS "B" Unit 8
In-Service Inspection of Concrete Containment Boundary
Nondestructive Test Results

Inspection Location		Test Results Rebound Number	Relative Strength (MPa)
Perimeter Wall			
North wall, El. 615'			
Between Col Lines K and L		41.7	37
North wall, El. 639'			
Between Col Lines E and F		44.8	41
East wall El. 615'			
Between Col Lines 8 and 9		47.6	47
East Wall El. 639'			
Between Col Lines 9 and 10		49.4	50
South wall El. 615'			
Between Col Lines D and E		40.7	35
South wall El. 639'			
Between Col Lines E and F		48.9	48
West wall El. 615'			
Between Col Lines 8 and 9		51.0	52
West wall El. 639'			
Between Col Lines 7 and 8		42.7	38
Main Girders			
East Girder -	west side of north end El. 675'	51.1	52
	east side of north end El. 696'	50.6	51
	east side of south end El. 675'	51.9	53
	east side of south end El. 696'	47.4	46
West Girder -	east side of north end El. 675'	51.0	52
	east side of north end El. 696'	51.4	52
	east side of south end El. 675'	51.1	52
	east side of south end El. 696'	48.8	48
Wall of Fuelling Machine Duct			
Elevation 579'	Between Col Lines 8A and 8B	44.9	42
	Between Col Lines 8N and 8P	41.3	36
Elevation 591'	Between Col Lines 8A and 8B	47.7	47
	Between Col Lines 8M and 8N	46.7	45

Table 2 (cont'd)

Bruce NGS "B" Unit 8
In-Service Inspection of Concrete Containment Boundary
Nondestructive Test Results

Inspection Location	Test Results Estimate of Crack Depth Using Ultrasonic Pulse Velocity Readings (mm)
Horizontal crack Between High Stress Areas 2 and 3 Elevation 663' - Ultrasonic pulse velocity in sound concrete 4100 m/s	125 150 165 155
Horizontal crack in High Stress Area 3 Elevation 663' - Ultrasonic pulse velocity in sound concrete 4100 m/s	65 220 185 175 220
Horizontal crack in Fuelling Machine Duct Wall Elevation 591' between Col Lines 8P and 8O - Ultrasonic pulse velocity in sound concrete 4050 m/s	210 180 175 160
Vertical crack in Fuelling Machine Duct Wall Elevation 579' between Col Lines 8N and 8P - Ultrasonic pulse velocity in sound concrete 4050 m/s	135 150 190 205
Vertical crack in Fuelling Machine Duct Wall Elevation 579' between Col Lines 8A and 8B - Ultrasonic pulse velocity in sound concrete 4100 m/s	190 120 235 215

Table 3

Inspection of High Stress Areas

The high stress areas, as identified in the work plan prepared by CPSD, are shown in Figure 7.

High Stress Area Elevation 615'	Observations
1	- horizontal crack (width 0.25 mm) across the corner
2	- no cracks noted
3	- no cracks noted
4	- no cracks noted
5	- no cracks noted
6	- minor random cracks (width 0.15 mm)
7	- minor random cracks (width 0.15 mm)
8	- no cracks noted
9	- not accessible
Elevation 639'	
1	- only west side accessible - horizontal crack (width 0.15 mm)
2	- not accessible
3	- no cracks noted
4	- only west side accessible - no cracks noted
5	- diagonal crack (width 0.50 mm) at lower corner of wall
6	- hairline cracks (width < 0.05 mm)
7	- hairline cracks (width < 0.05 mm)
8	- horizontal cracks (width 0.25 mm) across corner
'9	- random cracks (width < 0.15 mm) near corner

Table 3 (cont'd)

Inspection of High Stress Areas

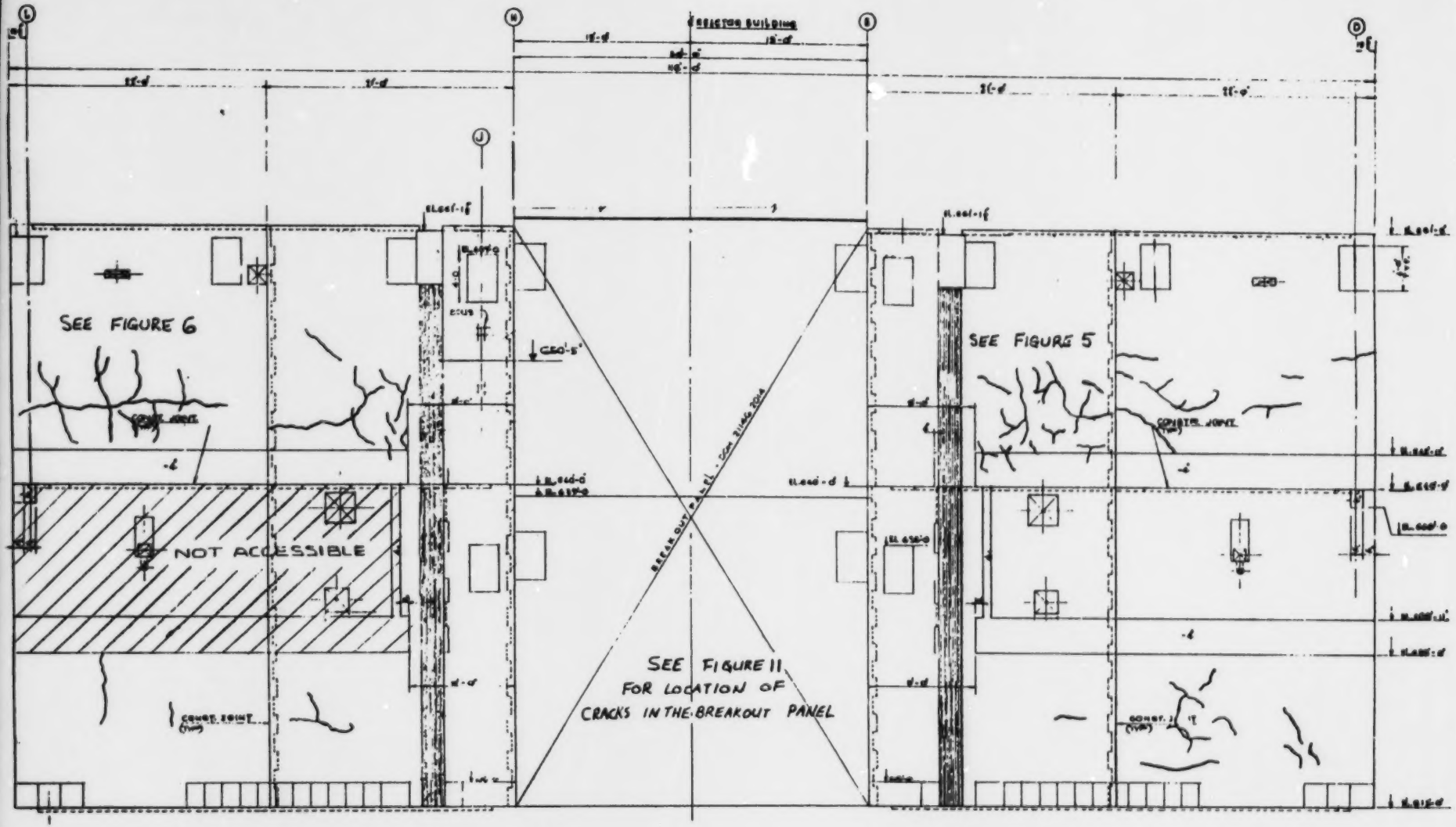
High Stress Area Elevation 663'	Observations
1	- south wall not accessible - two horizontal cracks (width 0.15 mm) extend from corner (Figure 8)
2	- horizontal crack (width 0.50 mm) extends from High Stress Area 2 to 3 - vertical cracks (width 0.50 mm) extend from the horizontal crack (Figure 9)
3	- See High Stress Area 2 - vertical cracks (width < 0.15 mm) at changes in profile of wall - random cracks (width < 0.15 mm)
4	- horizontal cracks (width < 0.15 mm) across corners
5	- random cracks (width < 0.15 mm)
6	- random cracks (width < 0.15 mm)
7	- two horizontal cracks (width 0.50 mm) extend across corner
8	- hairline cracks (width < 0.05 mm) across corner (Figure 10)
9	

Note: Similar cracking as reported between High Stress Areas 2 and 3 was present at similar locations on the northeast (crack width 0.25 mm) and southeast (crack width 0.25 mm) of the reactor buidling.

Table 4

Bruce NGS "B" Unit 8
Inspection of Main Girders and Post-Tensioned Anchorages

Location	Elevation	Remarks
West Girder - north end	678'	- a few hairline cracks were present; however, they were generally covered with paint
West Girder - north end	693'	- anchorage inspected from a distance - only small hairline cracks observed
West Girder - south end	678'	- a few hairline cracks were present; however, they were generally covered with paint
West Girder - south end	693'	- grease observed leaking from anchorage cap - hairline cracks propagate from the anchorage zone (Figure 12) - random hairline cracks present in the end of the girder (Figure 13)
East Girder - north end	678'	- east and west sides of girder not readily accessible, but no major cracks were observed from a distance - a few hairline cracks were present in the end of the girder
East Girder - north end	693'	- west side of girder not accessible - cracks propagating from the anchorage zone had a maximum width of 0.25 mm (Figure 14)
East Girder - south end	678'	- a few hairline cracks were present; however, they were generally covered with paint - three nozzles of the tendon anchorage caps were missing (Figure 5)
East Girder - south end	693'	- west side of girder not accessible - the west cap to the north of the girder appears to have leaked grease in the past (ie, stains on the concrete) - the cracks observed were hairline and had been painted over
East and West Girders East and West Elevations	All	- all accessible surfaces were visually inspected - vertical cracks were present with widths up to 0.25 mm

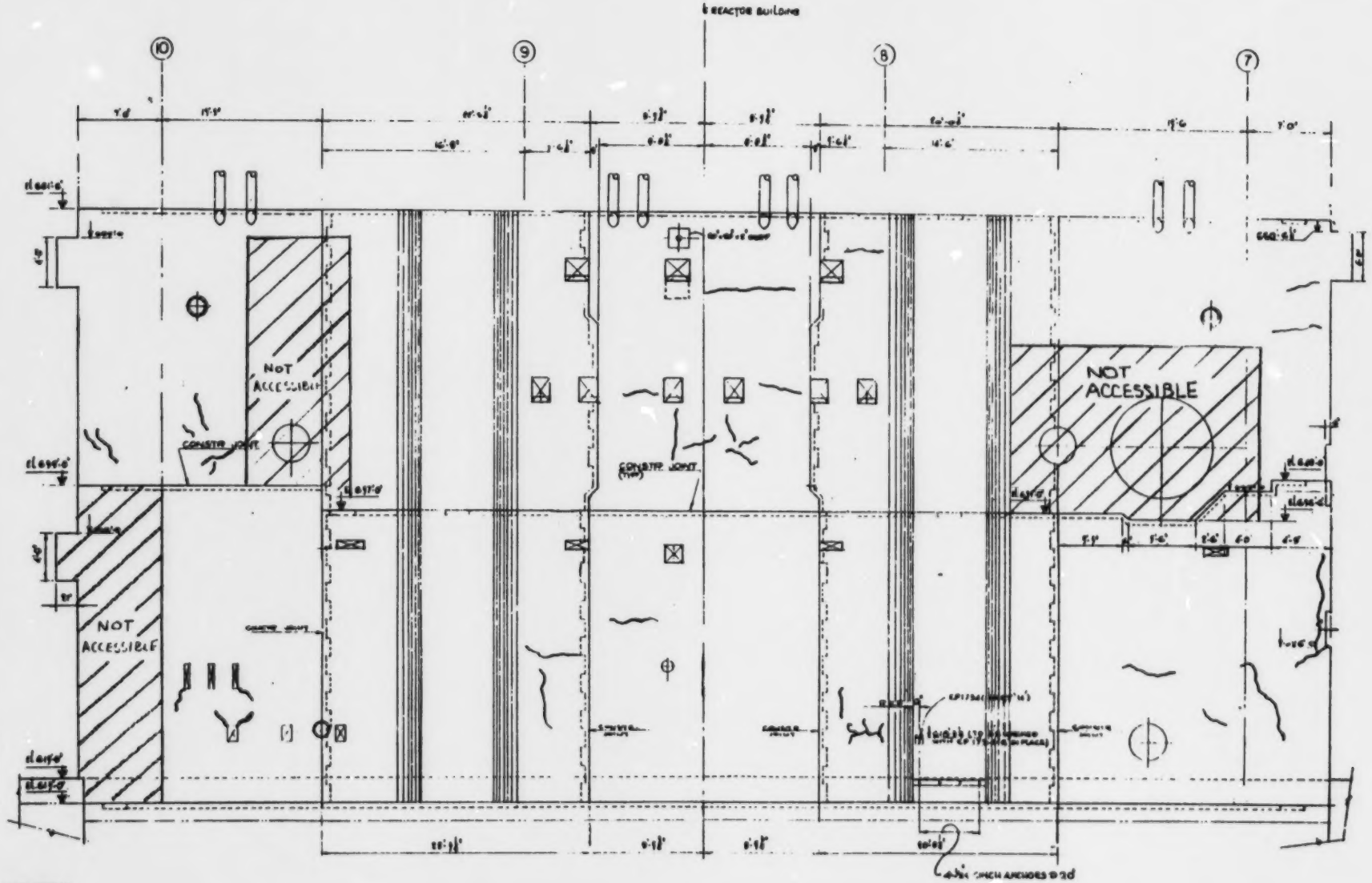


NOTES

Location of cracks

Crack widths less than 0.15 mm

FIGURE 1
BRUCE NGS 'B', RB#8
REACTOR BUILDING
EXTERIOR NORTH WALL

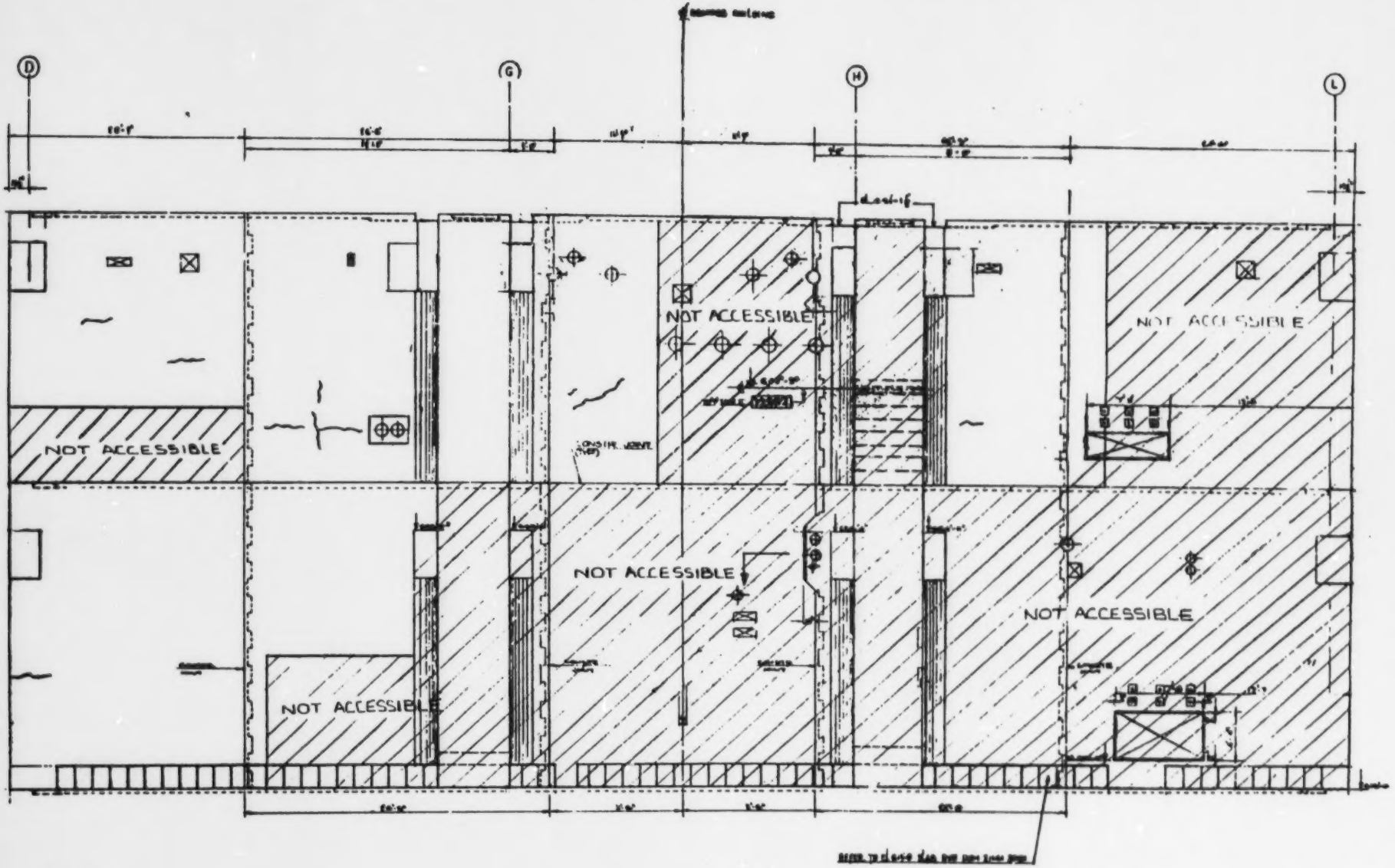


NOTES

Location of cracks

Crack widths less than 0.15 mm

FIGURE 2
BRUCE NGS 'B', RB#8
REACTOR BUILDING
EXTERIOR EAST WALL

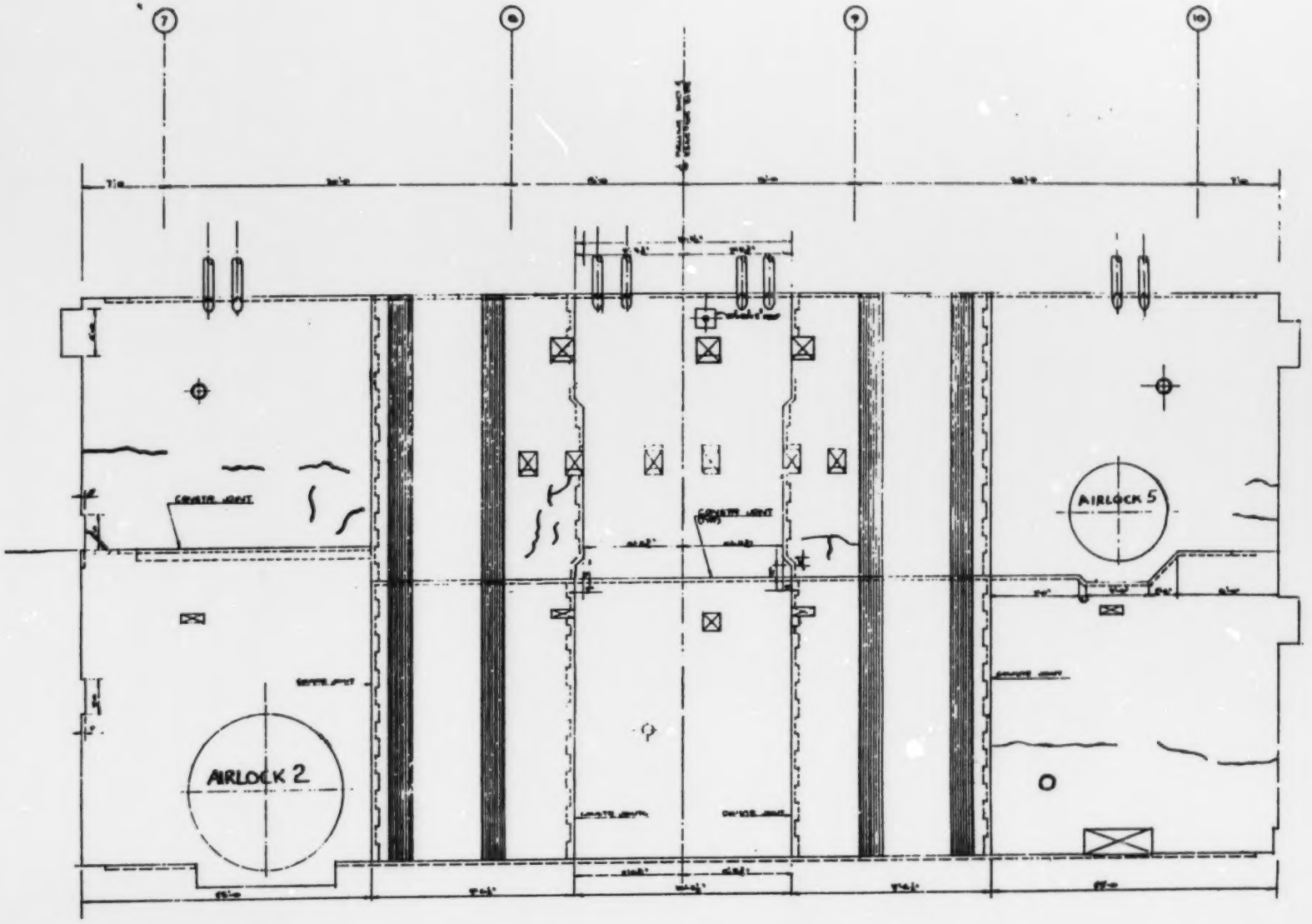


NOTES

Location of cracks

Crack widths less than 0.15 mm

FIGURE 3
BRUCE NGS 'B', RB#8
REACTOR BUILDING
EXTERIOR SOUTH WALL



NOTES

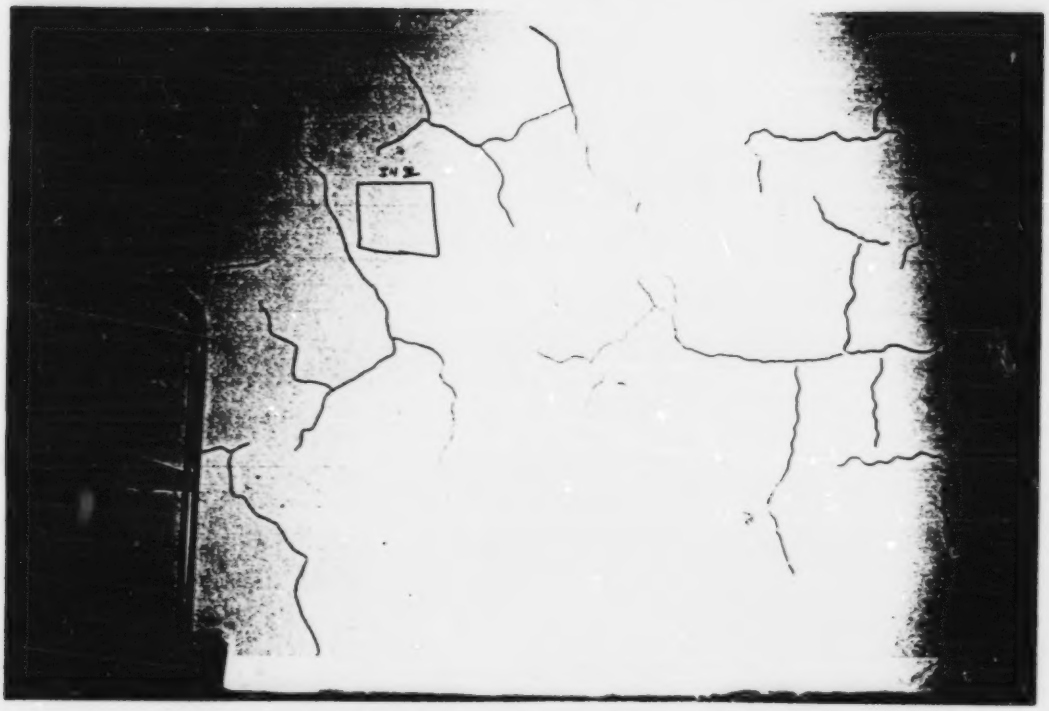


Figure 5 - Section of the perimeter wall on the north side of the Unit 8 reactor building at Elevation 639' between Col Lines E and F.

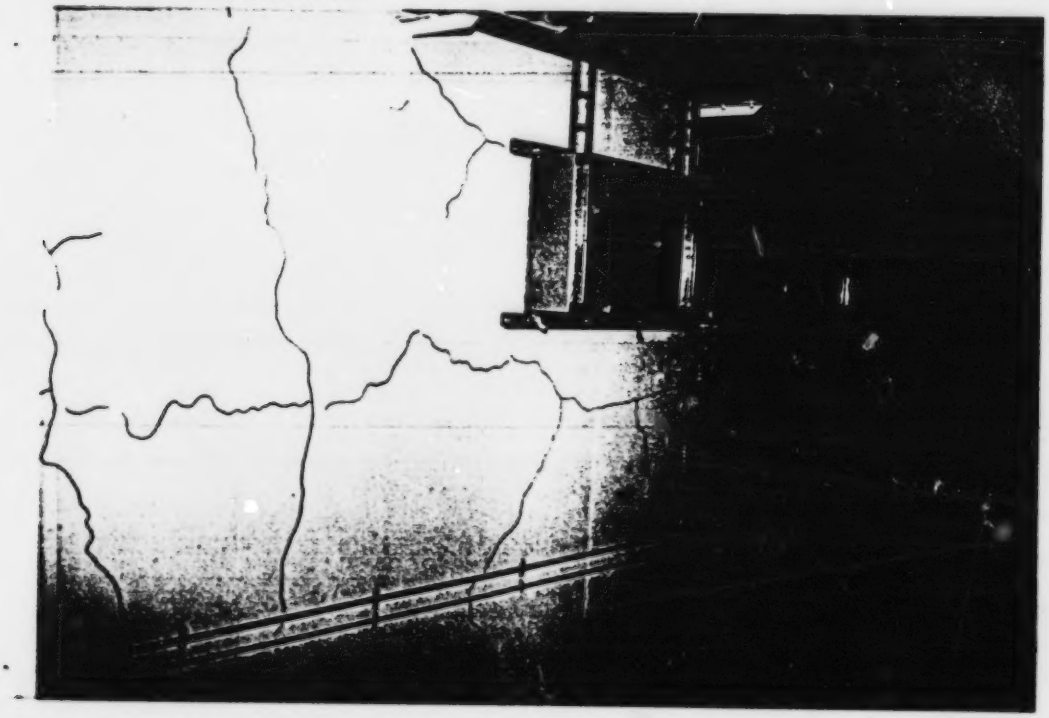
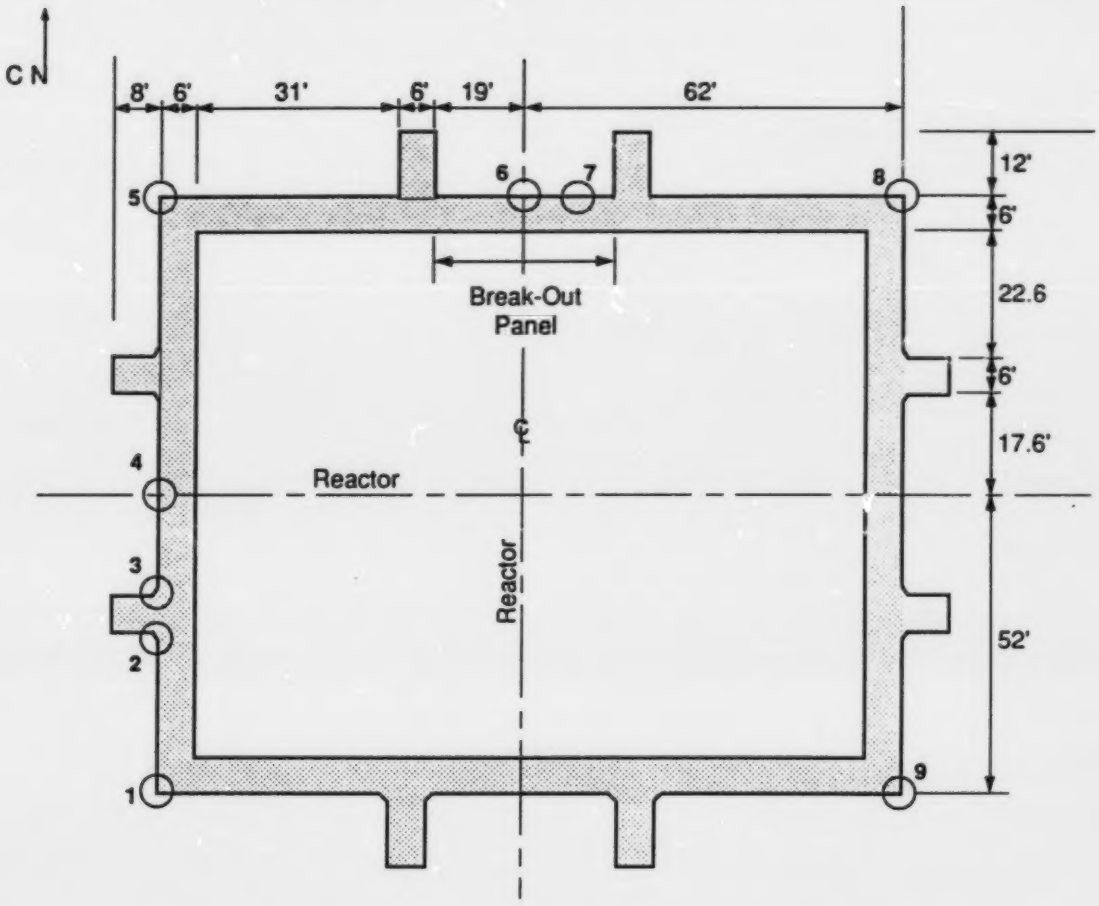


Figure 6 - Section of the perimeter wall on the north side of the Unit 8 reactor building at Elevation 639' between Col Lines K and L.



○ - Critical Areas Where Concrete Should Be Examined

FIGURE 7

BRUCE NGS "B" REACTOR BUILDING
PLAN VIEW
LOCATION OF HIGH STRESS AREAS

181973-L10-RD

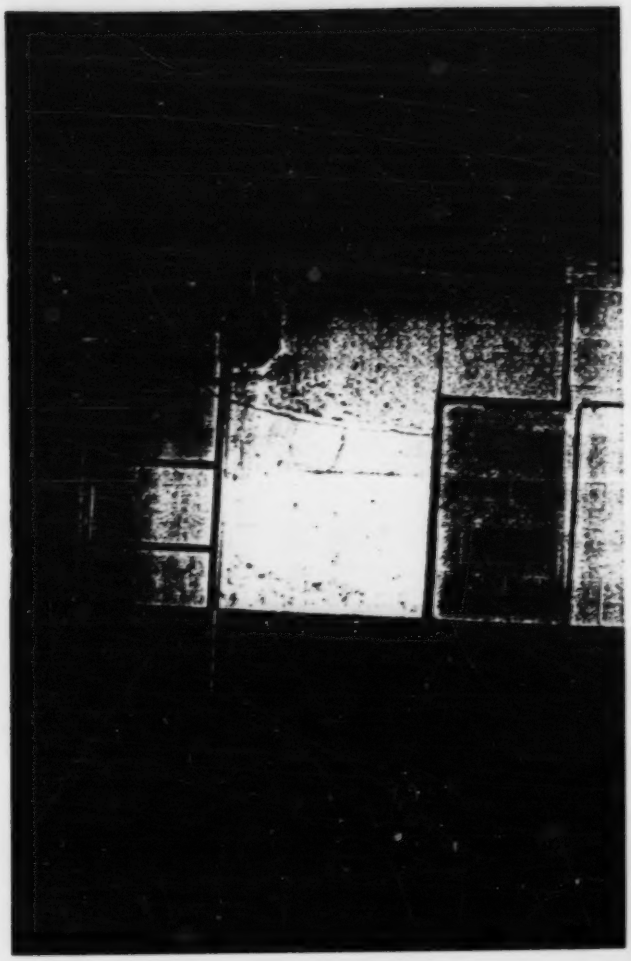


Figure 8 - High Stress Area 1 at Elevation 663' showing the location of two horizontal cracks (width 0.15 mm).

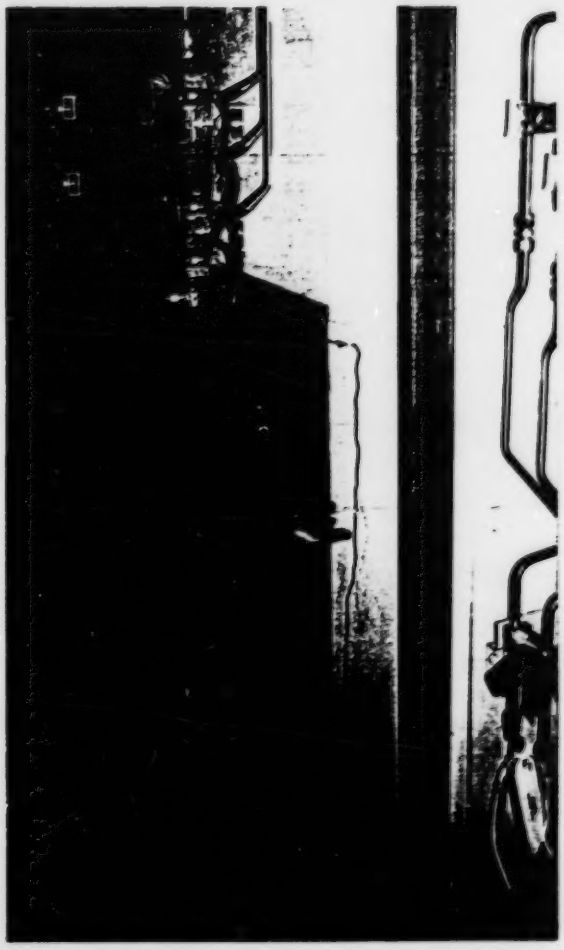


Figure 9 - Horizontal and vertical cracks (width 0.50 mm) between High Stress Areas 2 and 3 at Elevation 663'.

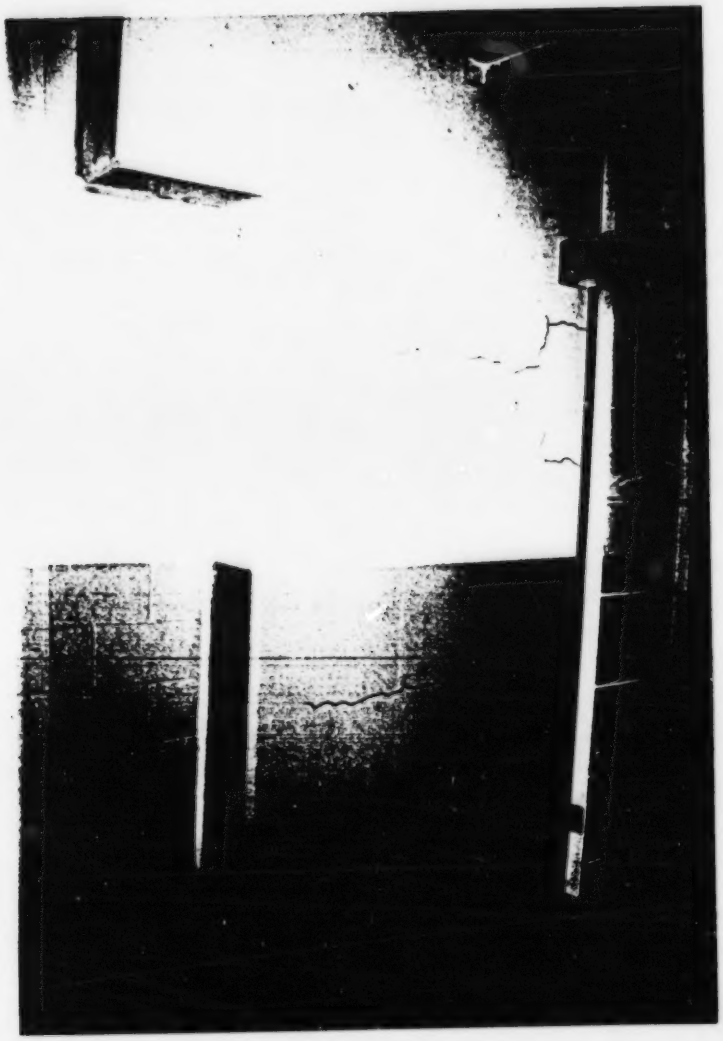


Figure 10 - Horizontal cracks at High Stress Area 9 at Elevation 663'.

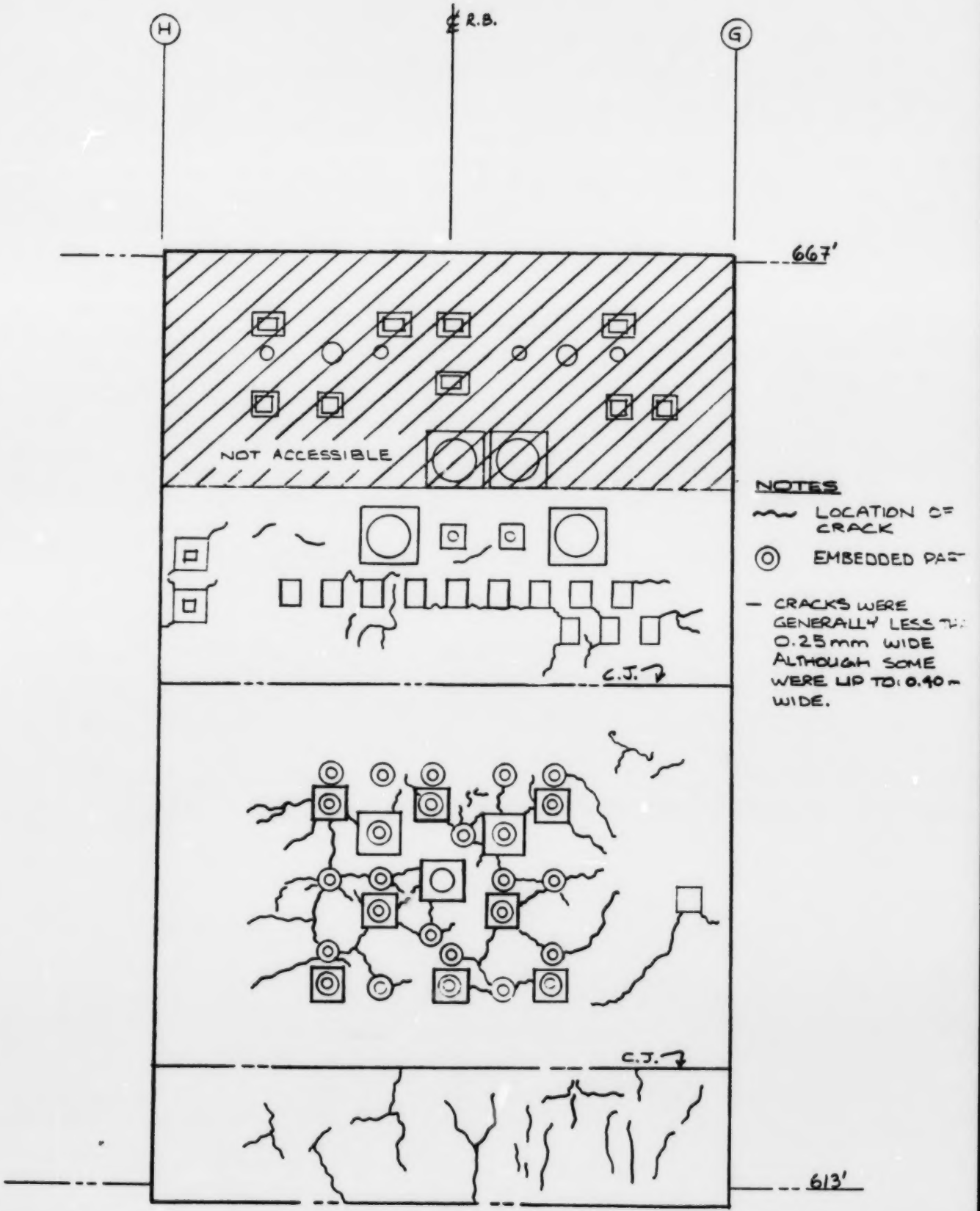


FIGURE 11
BRUCE NGS 'B' RB 8
REACTOR BUILDING
BREAKOUT PANEL

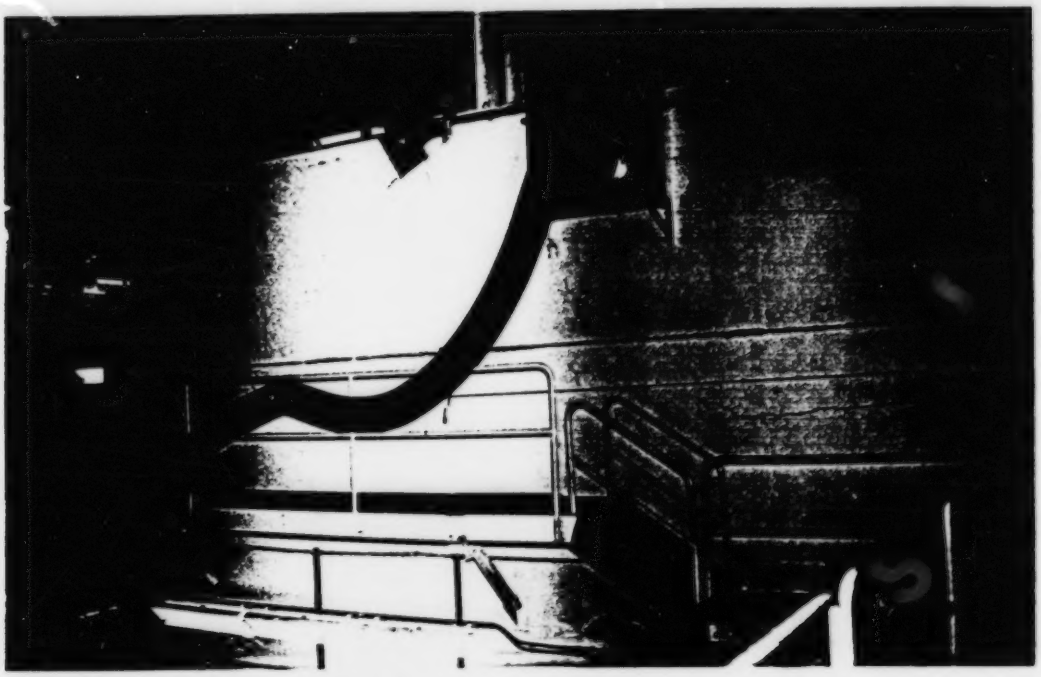


Figure 12 - East face at the south end of the west girder at Elevation 693'. The locations of cracks are marked on the concrete.

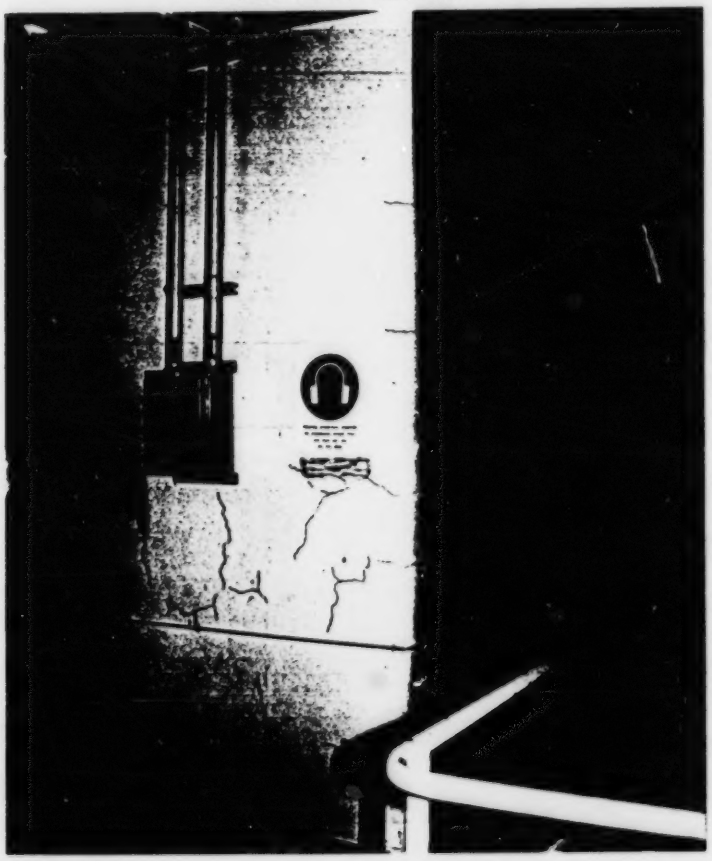


Figure 13 - South end of the west girder at Elevation 693' showing the location of cracks.

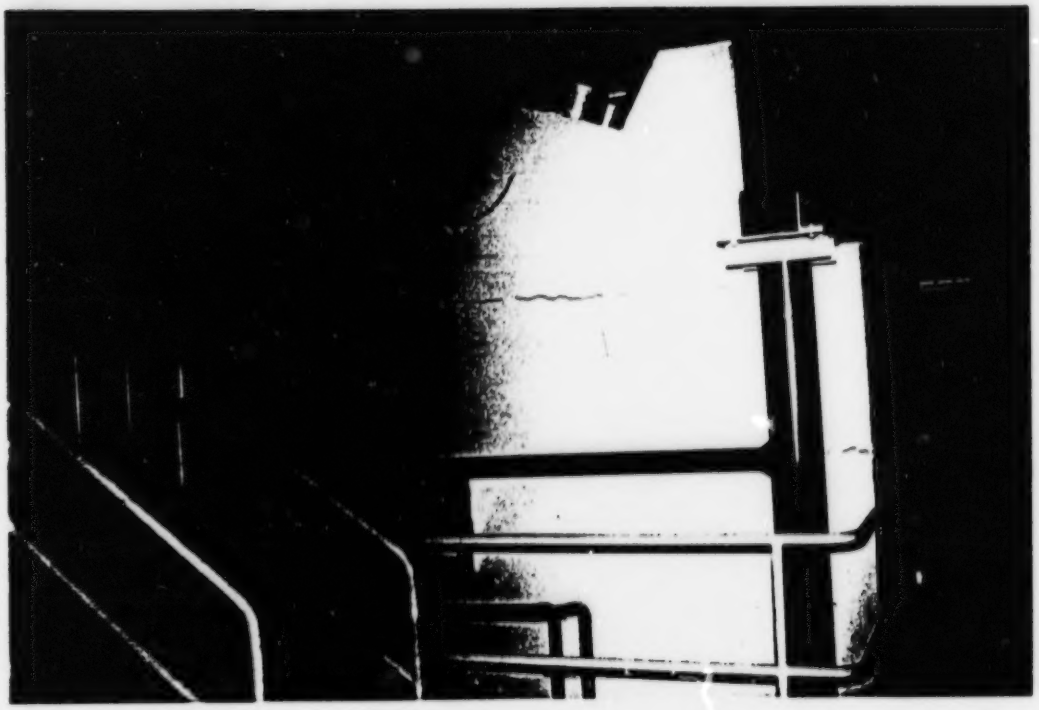


Figure 14 - East face at the north end of the east girder at Elevation 693'. The locations of cracks are marked on the concrete.

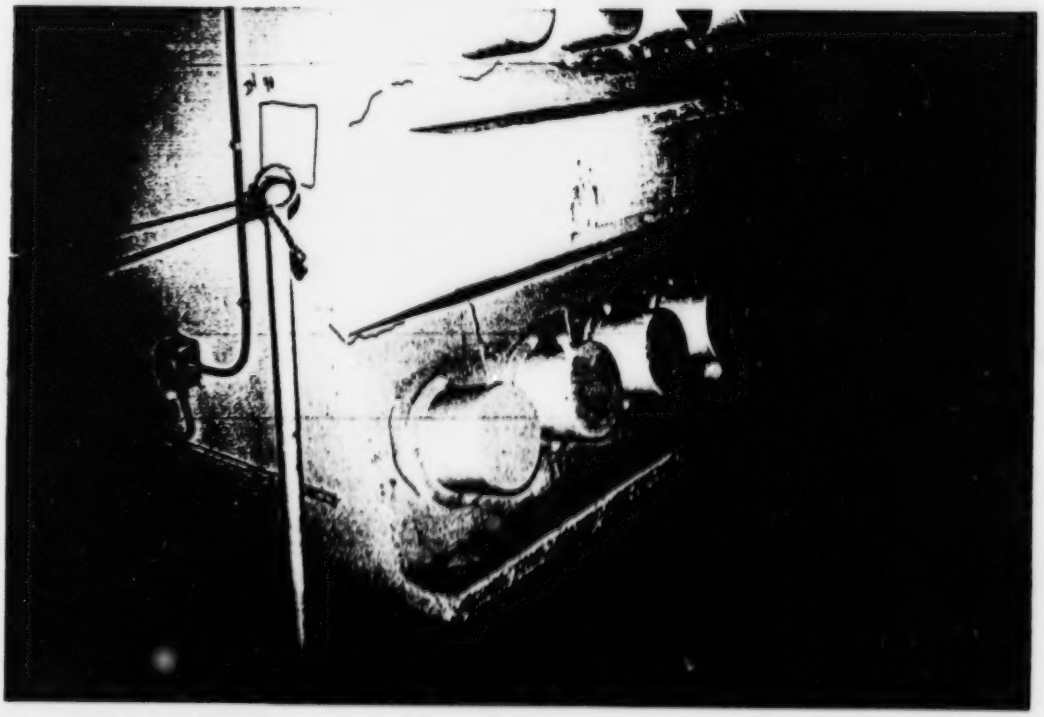
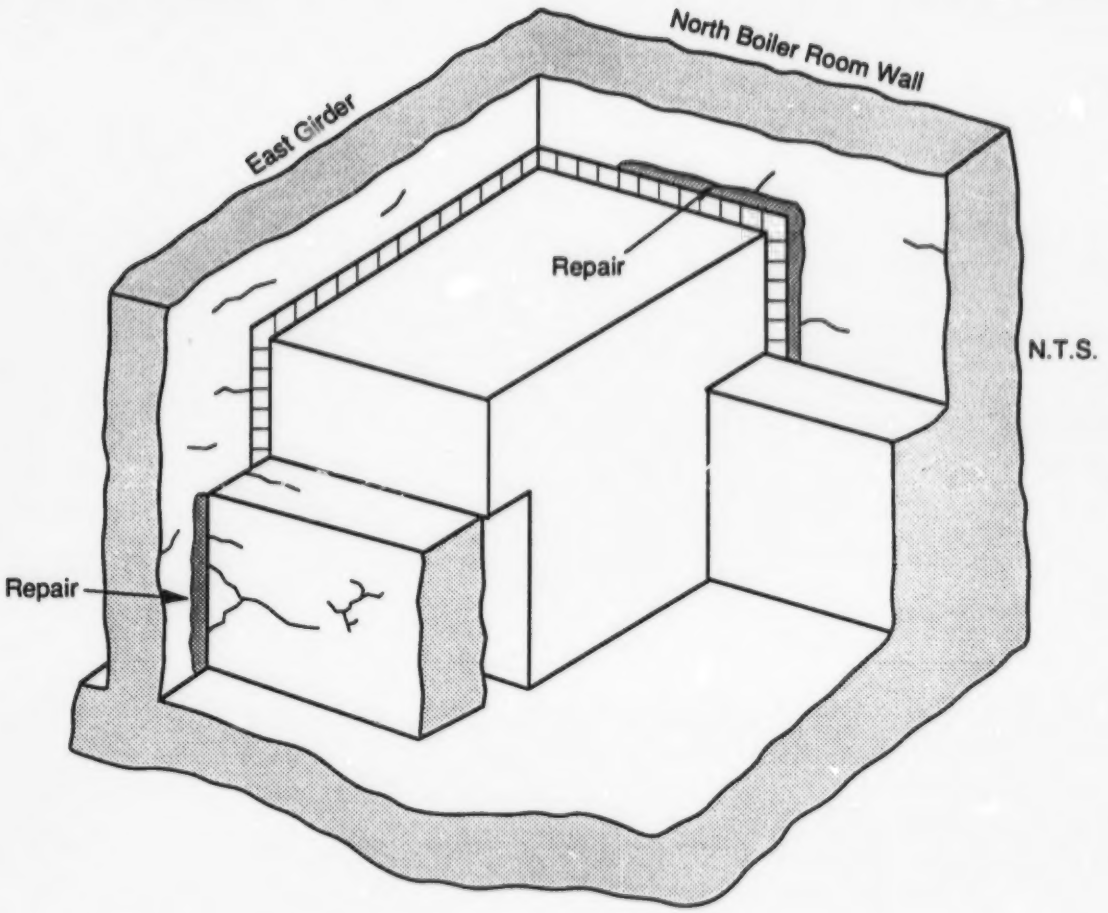


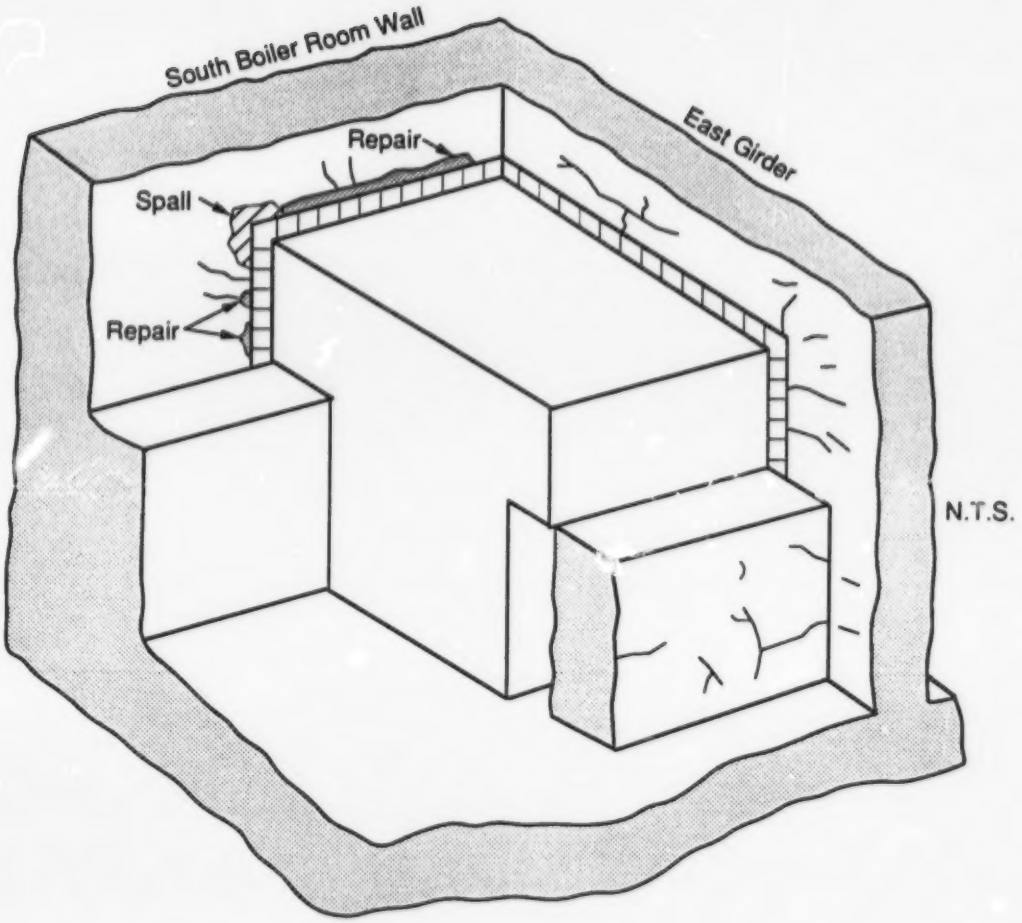
Figure 15 - South end of the east girder at Elevation 678'. Three of the nozzels on the lower set of tendon anchorage caps were missing.



General Notes: Crack width < 0.15 mm unless otherwise noted
No signs of concrete deterioration

FIGURE 16

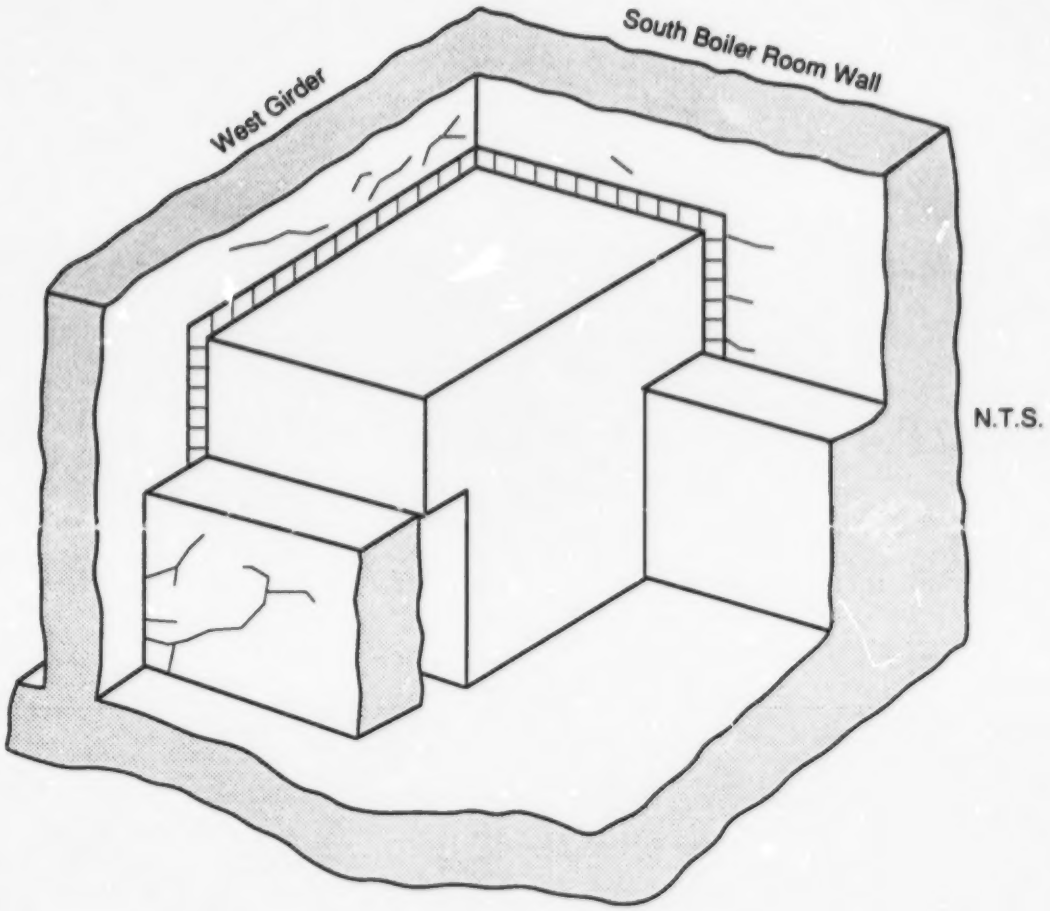
UNIT 8 - NORTHEAST PREHEATER ENCLOSURE
CONCRETE INSPECTION



General Notes: Crack width < 0.15 mm

FIGURE 17

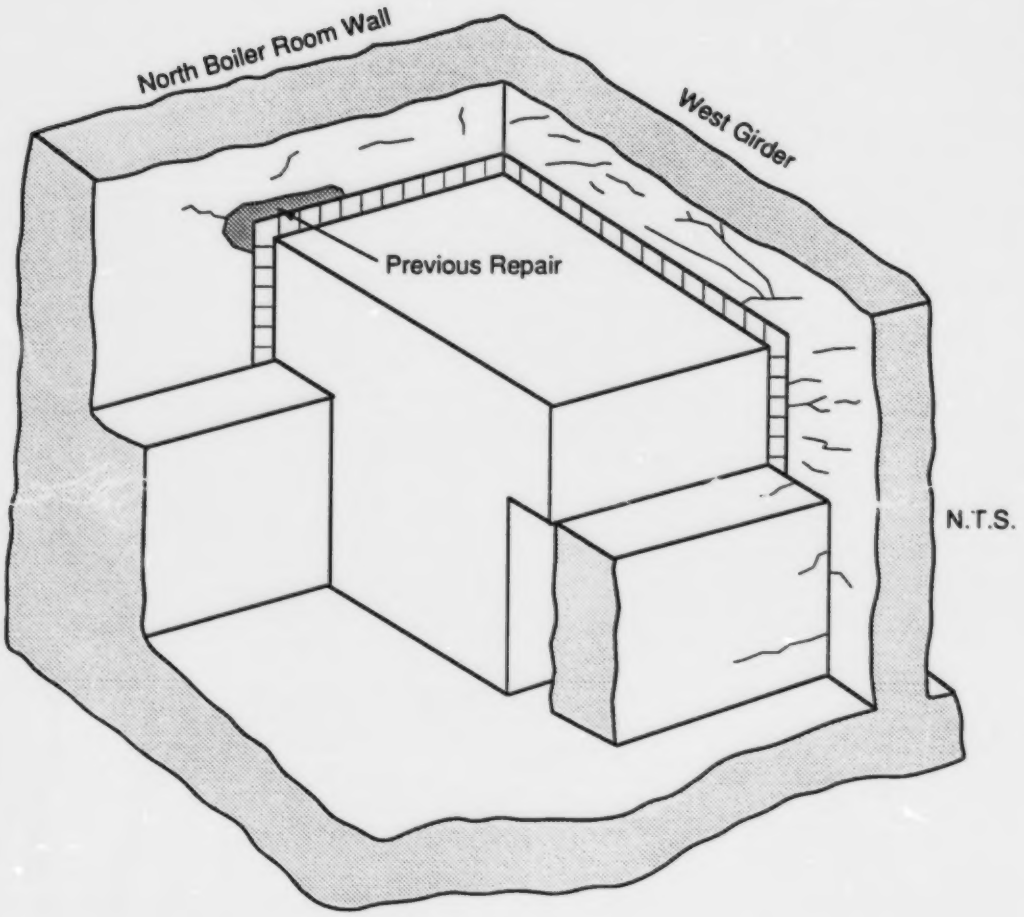
UNIT 8 - SOUTHEAST PREHEATER ENCLOSURE CONCRETE INSPECTION



General Notes: Crack width < 0.15 mm
No signs of concrete deterioration

FIGURE 18

UNIT 8 - SOUTHWEST PREHEATER ENCLOSURE CONCRETE INSPECTION



General Notes: Crack width < 0.15 mm
No signs of concrete deterioration

FIGURE 19

UNIT 8 - NORTHWEST PREHEATER ENCLOSURE CONCRETE INSPECTION

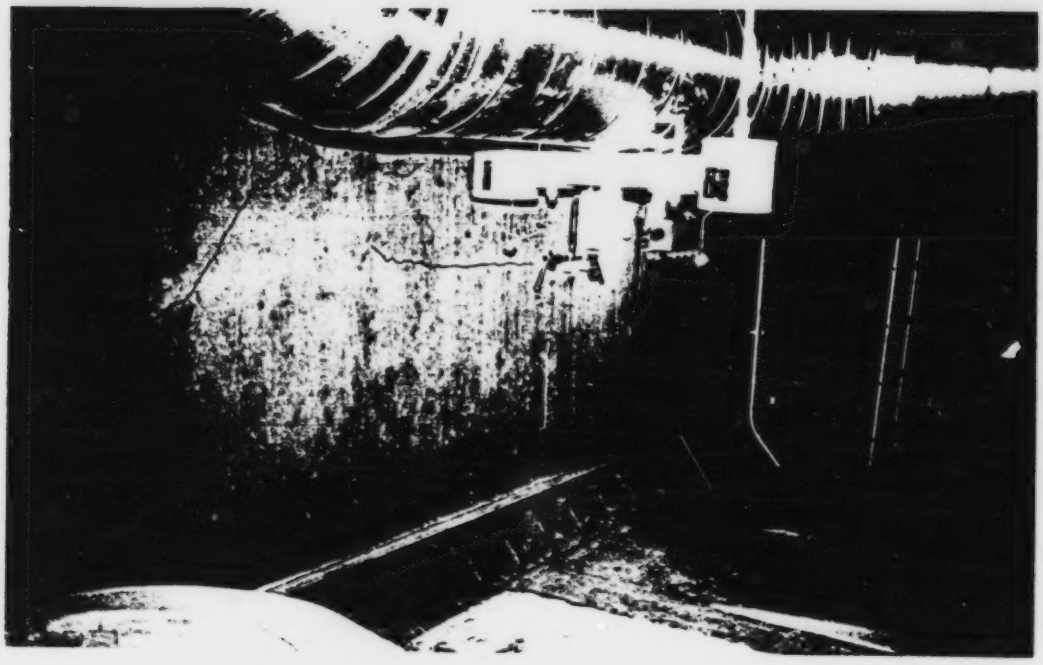


Figure 20 - Typical cracking in the concrete around the northeast preheater enclosure.

Figure 21 - Spalled concrete on the south wall of the east boiler room around the preheater enclosure.

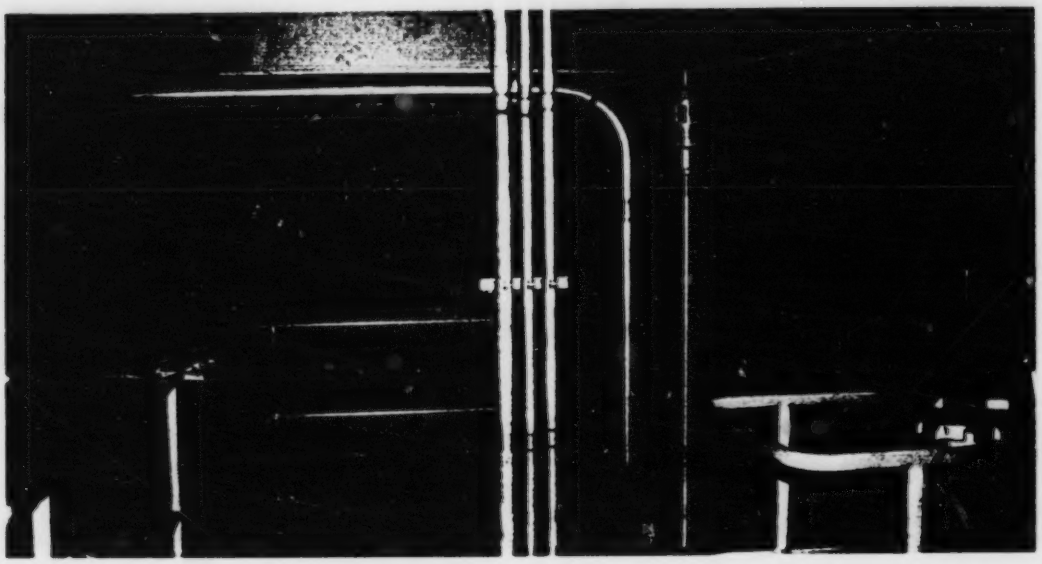


Figure 22 - Typical cracking observed in the south wall of the fuelling machine duct at Elevation 591' between Col Lines 8P and 8O.

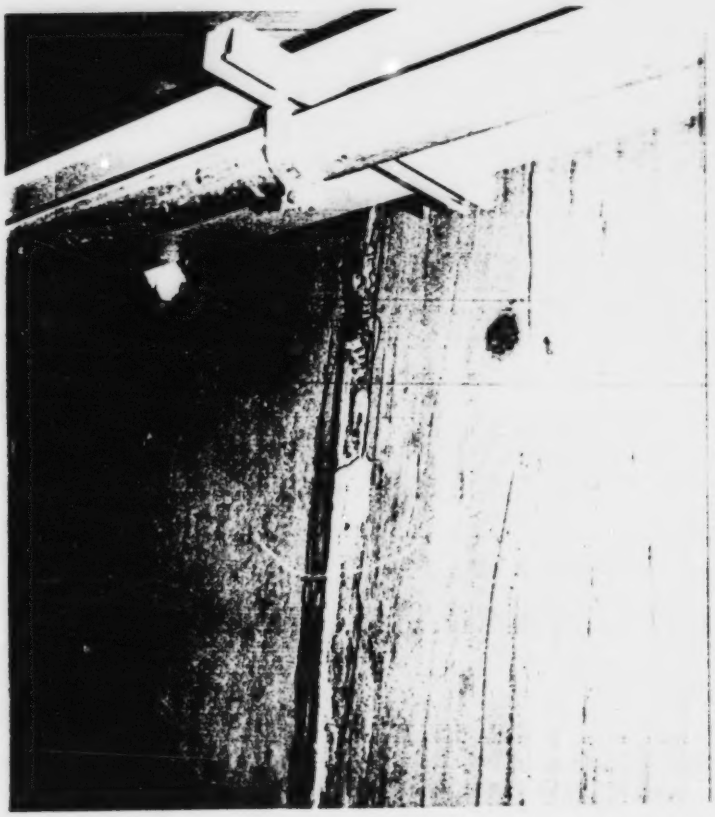


Figure 23 - Small spalled area exhibiting efflorescence along a vertical construction joint on the fuelling machine duct at Elevation 591' between Col Lines 8P and 8O.